SCT ASIC PRR Document

ABCD3TA ASIC: QA

Abstract

This document describes the quality assurance procedure to be applied in production of the ABCD3TA ASICs.

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History of Changes

Rev. No.	*Date*	*Pages*	*Description of Changes*

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1 SCOPE OF THE DOCUMENT

This document describes the QA procedure to be applied to ABCD3TA ASICs during production. The QA procedures will be realised at several stages, some of them described in other documents. In this document we refer to the other relevant documents and describe the procedures for QA with respect to radiation resistance of the ABCD3TA ASICs.

Full QA will be applied to ABCD3TA ASICs at two stages:

A) qualifying good dies on wafers,

B) checking for infant mortality in ASICs assembled onto hybrids,

Radiation resistance will be monitored on sampling basis as these are destructive tests. The irradiation tests will be performed at three stages:

A) with respect to total ionising dose, the process control monitors will be irradiated with X-ray in the foundry

B) with respect to NIEL, the ABCD3TA chips will be irradiated with neutrons,

C) a small number of modules will be irradiated with protons.

2 SELECTION OF ASICS ON WAFERS

After receiving the wafers 100% of the ASICs will be tested fully tested and only ASICs passing all test criteria will be used for module building. The test procedure and qualification criteria are described in details in the document "Test Specification for ABCD3T Wafer Screening".

3 INFANT MORTALITY TEST OF ASICS ON HYBRIDS

A long duration test will be performed for ASICs assembled on hybrids. The aim of this test is to catch infant mortality problems in the ASICs. The test is therefore performed at the first stage where it is feasible and practical and replacing ASICs is still possible. The test consists of a long duration run at elevated temperature, initially for 100 hour with temperature measured on the hybrid of 45 °C.

A detailed description of the test is given in the SCT Barrel Module FDR Document: "SCT Barrel Module: Module QA".

4 MONITORING OF RADIATION RESISTANCE

4.1 FOUNDRY RADIATION HARDNESS ASSURANCE

Radiation hardness verification is a part of the acceptance criteria in the foundry. A 10 Mrad (SiO_2) radiation test is done to control radiation hardness stability and to measure statistically the process capability to satisfy radiation sensitive parameter drift tables as specified in the DMILL electrical specification document (RDER2401). Each production lot is controlled according to the sampling plan defined in the in-house procedure EHR97043. Test conditions and radiation conditions are described in this document. After irradiation, in case one parameter exhibits larder drift or greater absolute value than expected a deeper analysis is performed and, when failure is confirmed, wafers are rejected.

4.2 NEUTRON IRRADIATION

Radiation hardness tests with respect to displacement damages (NIEL) will be performed for ASICs. Three chips from each lot of 25 wafers will be sampled and irradiated in the TRIGA reactor at Ljubjlana to a fluence of 2.0×1014 n(1 MeV eq.)/cm2. Irradiations will be performed with a neutron flux of $4.5x10^{11}$ n(1 MeV eq.)/cm^2 so the target fluence will be reached in a couple of minutes. Because of such a short irradiation time the delay caused by reactor scheduling will not be longer than 10 days. The time between irradiation and measurements, needed for deactivation, will also not be longer than 10 days. The chips will be irradiated on hybrids assembled with 12 chips so samples from four

consecutive lots will be irradiated in the same time. This will provide continuos monitoring of radiation hardness performance with a delay 4 weeks at maximum after assembling the chips on hybrids.

Neutron energy spectrum in the reactor in Ljubljana has been determined by activation measurements of foils for different materials. For the measured spectrum a NIEL scaling factor between the actual neutron flux of fast neutron (E>100keV) the flux of 1 MeV eq. neutrons has been established to be κ = 0.90. The flux of 1 MeV eq. neutrons is regularly checked by irradiating dedicated Si diodes and measuring their leakage after annealing.

Full electrical characterisation of ASICs assembled on hybrids, as defined in the Electrical Tests document (see http://hepwww.rl.ac.uk/atlas-sct/documents/Electrical_Tests.htm) will be performed before and after irradiation at Ljubljana. The ASICs will be irradiated without bias.

4.3 IRRADIATION OF COMPLETED MODULES

A very small sample of the completed barrel modules (approximately 10 per annum during the construction period) will be fully and uniformly irradiated in the SCT facility at the CERN PS to a fluence of $3x10^{14}$ pcm^{-2} 24 GeV/c protons. They will be annealed for 7 days at 25 °C following the irradiation and then checked for mechanical integrity and for noise performance, for full ASIC functionality and for detector leakage current when run cold at the SCT operating temperature. Several of these modules will also be tested in the beam for signal-to-noise and efficiency performance.

5 SUMMARY

The QA procedures for the ABCD3TA ASICs are designed to ensure the quality and performance for each IC delivered for SCT module building. They should cover selecting good dies and catching infant mortality for 100% chips and monitoring radiation hardness on sampling basis.